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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/816,958

04/05/2004

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EXAMINER

LE, DUNG ANH

ART UNIT

PAPER NUMBER

2818

MAIL DATE

DELIVERY MODE

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PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/816,958

Applicant(s)

TAKIGAWA ET AL.

Examiner

DUNG A. LE

Art Unit

2818

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 04 May 2007.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-15 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-15 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 05 April 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

Claim Rejections

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1, 2 and 11 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Sun et al. (2004/0168705 A1) in view of Okuda et al. (2002/0035762 A1).

Regarding claim 1, Sun teaches a method for fabricating a semiconductor device comprising the steps of:

forming an opening in a insulation film 303; forming an interconnection layer 302 of Cu [[0011] as a main material in the opening (especially refer to Fig. 3G and refer to related texts); and

concurrently spraying nitrogen gas and water vapor on the surface of the interconnection layer 302 buried in the opening (by using the applicator 52 in fig. 2) ([0039]-[0040], page 6, claim 1,7).

Sun does not teach concurrently spraying nitrogen gas and water in a liquid phase on the surface of the interconnection layer buried in the opening.

Okuda et al. disclose concurrently spraying nitrogen gas and water in a liquid phase on the surface of the interconnection layer (by using a gas-liquid mixing nozzle 1027 (especially see fig. 3, col 26, line 64- col 26, line 30 and refer to related texts).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to concurrently spraying nitrogen gas and water in a liquid phase on the surface of the interconnection layer buried in the opening in Sun 's method in order to enhance the oxidization of metal layer such as aluminum, copper film (col 26, lines 5-10).

Regarding claim 2, Sun also teaches that after the step of concurrently spraying the nitrogen gas and the water, the step of forming a diffusion preventing film 314 (fig. 3H and refer to related texts) for preventing the diffusion of the Cu on the insulation film and the interconnection layer.

Regarding claim 11, Sun teaches wherein in the step of concurrently spraying the nitrogen gas and the water, the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water [0044].

Claims 3, 8-9, 12 and 13 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Sun et al. in view of Okuda et al. and further in view of Ngo et al. (6472755).

Regarding claim 3, Sun in view of Okuda et al. teaches the claimed invention as applied to claims 1-2, including the diffusion preventing film 314 except the step of forming the diffusion preventing film is an SiC film or a silicon nitride film as cited in current claim.

Ngo teaches the diffusion preventing film 50 is an SiC film or a silicon nitride film (col 6, line 48-55).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to recognize the advantage and desirability to modify Sun 's method by form the diffusion preventing film is an SiC film or a silicon nitride film in order to provide a high quality, high reliability for the diffusion preventing layer .

It would have been obvious to one having ordinary skill in the art at the time the invention was made to form the diffusion preventing film is an SiC film or a silicon nitride film is commonly used to prevent undesirable or detrimental reactions in the contact region, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the desired application.

Regarding claim 8, wherein in the step of forming the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed (Ngo, figs. 2-3 and refer to related texts).

Regarding claim 9, wherein in the step of forming the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed (Ngo, figs. 2-3 and refer to related texts).

Regarding claim 12, wherein in the step of concurrently spraying the nitrogen gas and the water, the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water (Ngo, col7, lins 5-10).

Regarding claim 13, wherein in the step of concurrently spraying the nitrogen gas and the water, the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water (Ngo, col 7, lines 5-10).

Claims 7 and 15 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Sun et al. in view of Okuda et al. and further in view of the following remark.

Regarding claim 7, Sun et al. in view of Okuda et al. disclose the claimed invention as applied to claim 1 except for the step of forming the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to form the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed, this feature is commonly used to create the interconnect in the surrounding contact regions, since it has

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been held to be within the general skill of a worker in the art to select a known feature on the basis of its suitability for the practical use.

Regarding claim 15, wherein in the step of concurrently spraying the nitrogen gas and the water, the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water (Sun, [0044]).

Claims 5- 6 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Sun et al., Okuda et al. in view of Ngo and further in view of Li et al. (2004/0219795 A1).

Regarding claim 5, Sun, Okuda in view of Ngo et al. discloses the claimed invention as applied to claims 1- 2, except for the step of applying hydrogen plasmas to the surface of the insulation film and the surface of the interconnection layer.

Li et al. teach the step of applying hydrogen plasmas 38 to the surface of the insulation film 28 and the surface of the interconnection layer 36 (fig. 3, [0053]).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to applying hydrogen plasmas to the surface of the insulation film and the surface of the interconnection layer in Ngo's method, in order to improve the performance of the low-k dielectric or over which the copper interconnect has been created by increasing the breakdown voltage of the low-k

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dielectric, resulting in improved Time Dependent Dielectric Breakdown (TDDB), removed the layer of CuO or Cu.sub.20 from the surface of a created copper interconnect, reduced the dielectric constant of the low-k dielectric in or over which the copper interconnect has been created by removing carbon from the low-k dielectric and by thereby making the low-k dielectric more porous, and prevented damage to the surface of the low-k dielectric in or over which the copper interconnect has been created. ([0055]-[0058]).

Regarding claim 6, Sun, Okuda and Ngo et al. disclose the claimed invention as applied to claims 1-3 except for the step of applying hydrogen plasmas to the surface of the insulation film and the surface of the interconnection layer.

Li et al. teach the step of applying hydrogen plasmas 38 to the surface of the insulation film 28 and the surface of the interconnection layer 36 (fig. 3, [0053]):

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to applying hydrogen plasmas 38 to the surface of the insulation film and the surface of the interconnection layer in Ngo's method, in order to improve the performance of the low-k dielectric in or over which the copper interconnect has been created by increasing the breakdown voltage of the low-k dielectric, resulting in improved Time Dependent Dielectric Breakdown (TDDB), removed the layer of CuO or Cu.sub.20 from the surface of a created copper interconnect, reduced the dielectric constant of the low-k dielectric in or over which the copper interconnect has been created by removing carbon from the low-k dielectric and by thereby making the low-k dielectric

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more porous, and prevented damage to the surface of the low-k dielectric in or over which the copper interconnect has been created. ([0055]-[0058]).

Claims 4, 10 and 14 are rejected under 35 U.S.C. 103 (a) as being unpatentable over Sun et al. in view of Okuda and further in view of Li et al. (2004/0219795 A1).

Regarding claim 4, Sun et al. in view of Okuda discloses the claimed invention as applied to claim 1, except for the step of applying hydrogen plasmas to the surface of the insulation film and the surface of the interconnection layer.

Li et al. teach the step of applying hydrogen plasmas 38 to the surface of the insulation film 28 and the surface of the interconnection layer 36 (fig. 3, [0053]).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to applying hydrogen plasmas 38 to the surface of the insulation film and the surface of the interconnection layer in order to improve the performance of the low-k dielectric in or over which the copper interconnect has been created by increasing the breakdown voltage of the low-k dielectric, resulting in improved Time Dependent Dielectric Breakdown (TDDB), removed the layer of CuO or Cu.sub.2O from the surface of a create copper interconnect, reduced the dielectric constant of the low-k dielectric in or over which the copper interconnect has been created by removing carbon from the low-k dielectric and by thereby making the low-k dielectric more porous, and

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prevented damage to the surface of the low-k dielectric in or over which the copper interconnect has been created. ([0055]-[0058]).

Regarding claim 10, Sun , Okuda in view of Li et al. disclose the claimed invention as applied to claims 1 and 4, except for the step of forming the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to form the opening, the opening containing a via hole and an interconnection trench formed in a region containing the via hole is formed, this feature is commonly used to create the interconnect in the surrounding contact regions, since it has been held to be within the general skill of a worker in the art to select a known feature on the basis of its suitability for the practical use.

Regarding claim 14, step of concurrently spraying the nitrogen gas and the water, the water to be concurrently injected with the nitrogen gas is carbonated water or ozonized water (Sun, [0044]).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dung A. Le whose telephone number is (571) 272-1784. The examiner can normally be reached on Monday-Tuesday and Thursday 6:00am- 4:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stephen Loke can be reached on (571) 272-1657. The central fax phone numbers for the organization where this application or proceeding is assigned are (571)272-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/Dung A. Le/

DUNG A. LE
Primary Examiner
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